

ITOS Overview

ITOS User's Manual

\$Date: 2006/03/21 16:07:24 \$

Copyright 1999-2006, United States Government as represented by the Administrator of the National Aeronautics and Space Administration. No copyright is claimed in the United States under Title 17, U.S. Code.

This software and documentation are controlled exports and may only be released to U.S. Citizens and appropriate Permanent Residents in the United States. If you have any questions with respect to this constraint contact the GSFC center export administrator, <Thomas.R.Weisz@nasa.gov>.

This product contains software from the Integrated Test and Operations System (ITOS), a satellite ground data system developed at the Goddard Space Flight Center in Greenbelt MD. See <<http://itos.gsfc.nasa.gov/>> or e-mail <itos@itos.gsfc.nasa.gov> for additional information.

You may use this software for any purpose provided you agree to the following terms and conditions:

1. Redistributions of source code must retain the above copyright notice and this list of conditions.
2. Redistributions in binary form must reproduce the above copyright notice and this list of conditions in the documentation and/or other materials provided with the distribution.
3. All advertising materials mentioning features or use of this software must display the following acknowledgement:
This product contains software from the Integrated Test and Operations System (ITOS), a satellite ground data system developed at the Goddard Space Flight Center in Greenbelt MD.

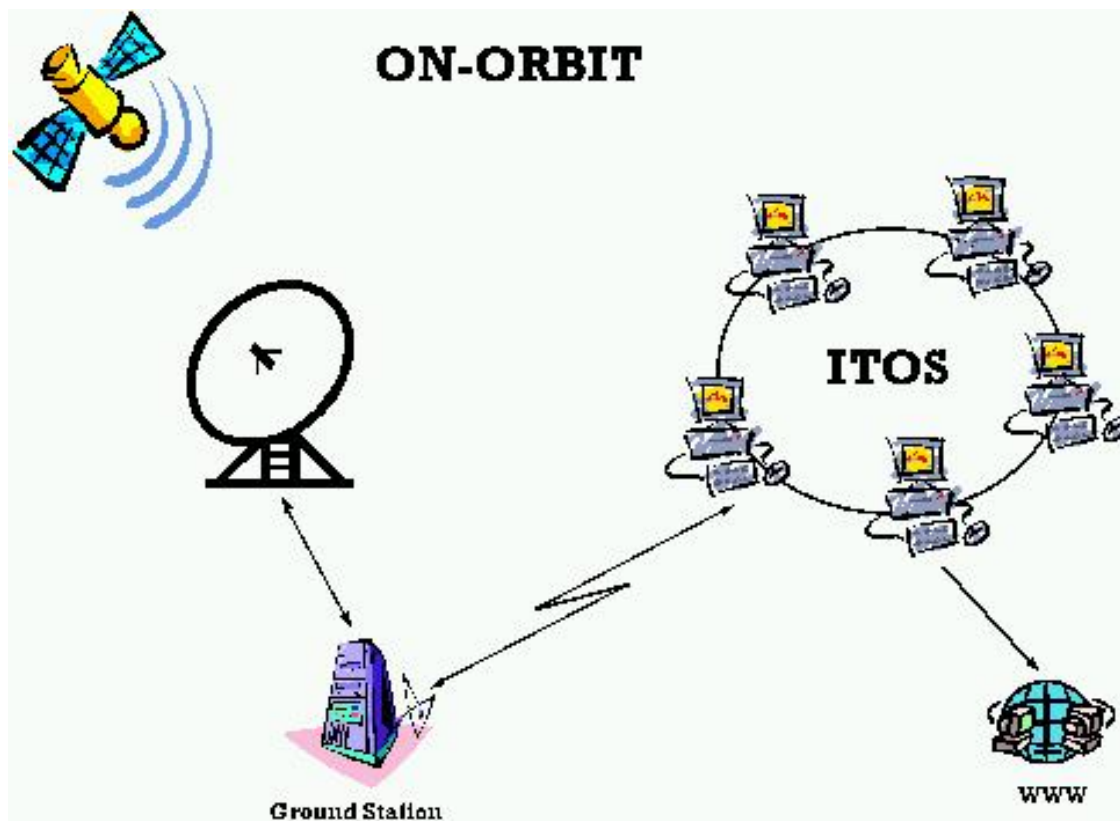
This software is provided ‘‘as is’’ without any warranty of any kind, either express, implied, or statutory, including, but not limited to, any warranty that the software will conform to specification, any implied warranties of merchantability, fitness for a particular purpose, and freedom from infringement and any warranty that the documentation will conform to their program or will be error free.

In no event shall NASA be liable for any damages, including, but not limited to, direct, indirect, special or consequential damages, arising out of, resulting from, or in any way connected with this software, whether or not based upon warranty, contract, tort, or otherwise, whether or not injury was sustained by persons or property or otherwise, and whether or not loss was sustained from or arose out of the results of, or use of, their software or services provided hereunder.

ITOS Overview

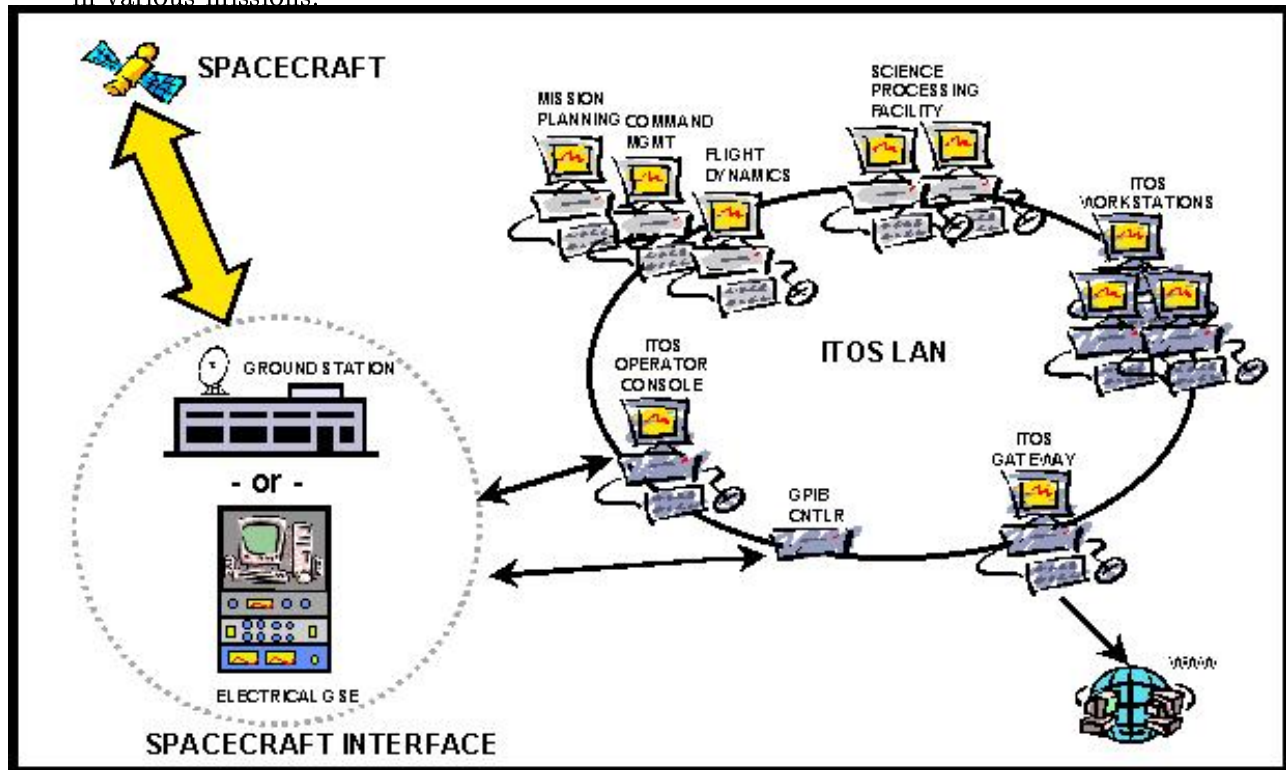
ITOS, the Integrated Test and Operations System, is a suite of computer software for controlling a satellite. Originally designed for detailed testing of satellite components during satellite integration, the ITOS also is being used in Mission Operations Centers (MOC) to fly satellites.

ITOS was the Integration and Test (I&T) system for the SAMPEX and FAST Small Explorer missions and is currently both the I&T and MOC system for Small Explorer, SPARTAN, and Triana missions.



This picture shows how ITOS fits into a satellite ground data system. In addition to ITOS, the ground data system has an antenna and associated RF equipment, bit and frame synchronizers, and a command modulator. Data from the satellite flows through the antenna and the bit and frame synchronizers before entering the ITOS; spacecraft commands go through the command modulator and antenna after leaving the ITOS.

ITOS can also be used during satellite integration and test (I & T); the following picture shows how ITOS can be used in a lab that's developing or testing a satellite subsystem or in various missions:



The ITOS configuration consists of a cluster of workstations interconnected over a local area network. Each workstation runs the complete ITOS software, with one designated as the primary operator console. This console receives data and sends commands to and from the spacecraft interface over an IP Ethernet connection. The primary console feeds the data it receives from the spacecraft interface to all other ITOS workstations. Each ITOS workstation unpacks the data packets and performs data processing tasks such as limit checking, engineering unit conversions, and configuration monitoring. ITOS has an event subsystem which recognizes spacecraft events, logs them, and forwards them to operators or external programs for processing. In addition, the primary ITOS console can distribute data via an IP Ethernet to other systems attached to the local area network; for example, the Science Processing Facility, Command Management System, Flight Dynamics System, and Mission Planning System.

ITOS Feature Summary

Distributed software architecture – runs on one machine or a cluster of machines.
Database driven – the same software can support multiple missions.
Low per-seat cost.
Automated operations via STOL procs.
State modeling via configuration monitors.
Lights out operations via configuration monitors.
Archive and playback telemetry data.
Monitor and control power supplies, bit syncs, dynamic simulators, and other lab equipment using IEEE-488 or RS-232.
Display data via traditional display pages.
Display data as strip charts or plots.
Display raw transfer frames.
Display raw packets.
Display data via Java applets over the World Wide Web.
Capture data via sequential prints.
Output data as CCSDS transfer frames to external applications.
Output data as CCSDS packets to external applications.
Output data as mnemonic values to external applications.
Maps non-CCSDS data to CCSDS transfer frames and packets.
Ingests telemetry over:
 TCP/IP where the telemetry source connects to the ITOS.
 TCP/IP where the ITOS connects to the telemetry source.
 UDP/IP.
Accepts telemetry as packets or transfer frames in a variety of encapsulations.
Easy to add telemetry encapsulations.
Accepts telemetry at better than 4 megabits/second.
Extracts and monitors health and safety data at better than 64 kilobits/seconds.
Telemetry data processed in software, not custom hardware.
Supports CCSDS COP-1 commanding.
Outputs commands over:
 TCP/IP where the ITOS connects to the destination.
 TCP/IP where the destination connects to the ITOS.
 UDP/IP (including multicast)
Outputs commands in a variety of encapsulations.
Unix based. Known to build and run correctly on:
 Sun Solaris, both Sparc and i386; 2.5.1, 2.6. and Solaris7

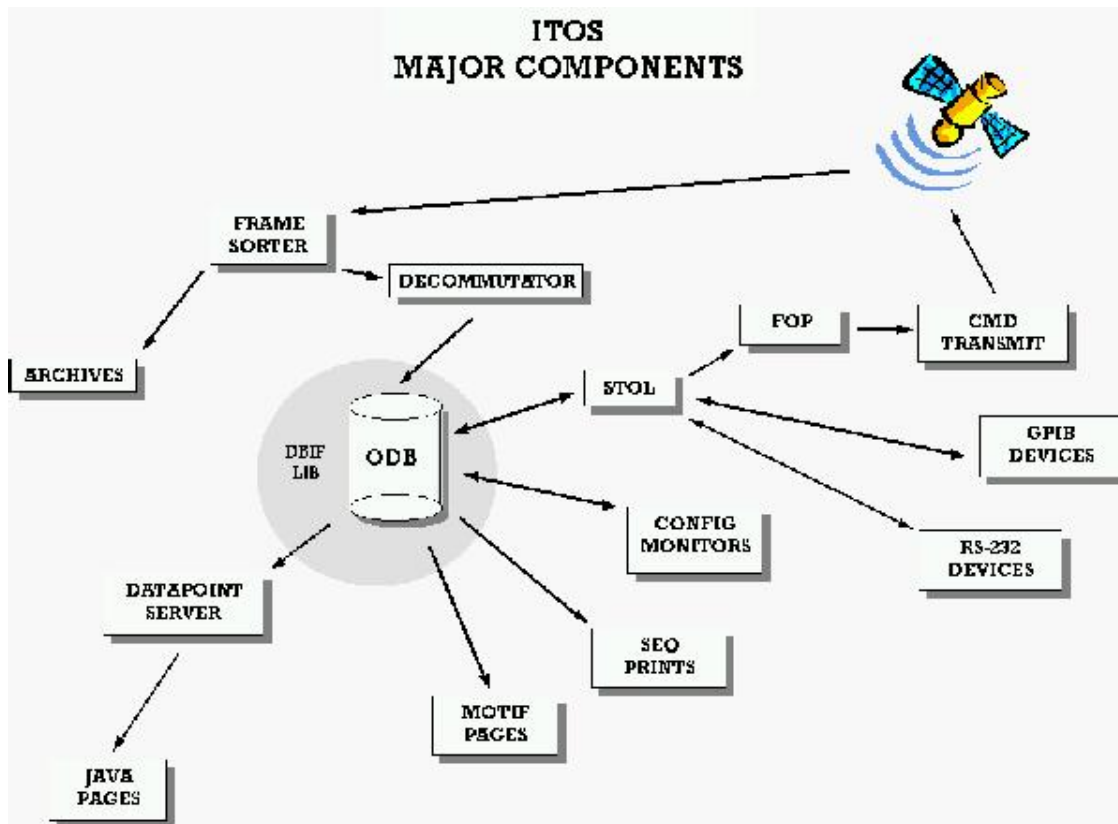
Hewlett Packard HPUX

FreeBSD 2.2.8 and Linux on i386

HTML-based help and database viewing.

Has been integrated with LabView.

ITOS Architecture



This picture shows the major components in ITOS. ITOS can also be viewed as consisting of the database subsystem, the telemetry subsystem, the command subsystem, the display subsystem, and STOL, the interface that runs the ITOS software.

Database subsystem overview

The database describes spacecraft commands and spacecraft telemetry. Each spacecraft command is described in terms of the command mnemonic, zero or more command fields, and submnemonic values. Spacecraft telemetry is described in terms of packet maps and mnemonics: a mnemonic is an individual data point, the packet maps describes where and from from which packet to extract the mnemonic. Mnemonics may have associated red and yellow high/low limits and analog or discrete conversions. The ITOS database does not require any commercial database package. The ITOS also includes tools for viewing the database over the World Wide Web.

The current value table contains the most recent value for each mnemonic. Most ITOS components obtain mnemonic values by polling the current value table. An alternative mechanism, where the component registers interesting mnemonics and gets notified every time a new value arrives, is also available.

Command subsystem overview

Output is CCSDS command transfer frames, encapsulated in CLTUs, NASCOM blocks, implements FOP, etc.

Telemetry subsystem overview

Other points to make in this section: packet reassembly/decom on the workstation; clusters have one workstation that gets frames and distributes packets to the other workstations; explain how PCM major frames can be mapped into CCSDS packets.

The telemetry subsystem accepts CCSDS packets, CCSDS transfer frames, or PCM major frames (which will be treated similar to CCSDS packets). These may be ‘wrapped’ in zero or more wrappers, including:

- anno12 – Twelve-byte annotation on packets, originally from the FTCP.
- fep521 – Wraps frames, developed for code 521.
- ftcp – itp header (see below) plus an 8 byte trailer.
- itp – 16 byte header (frames or packets), originally from the FTCP.
- smex – 10 byte header, described in TRACE-ICD-011.

The telemetry subsystem uses either the TCP or UDP protocol. In TCP, the telemetry subsystem can connect to the telemetry source or can listen for a connection from the telemetry source – the telemetry subsystem can behave as either the client or the server.

Display subsystem overview

?

STOL overview

STOL is the primary interface for controlling the ITOS software. STOL directives may be entered interactively in the stol input window; more commonly directives are organized into STOL procs, powerful scripts using if-then-else, do-while, and wait-until control structures. STOL can also access telemetry values and can perform complex arithmetic using those values.

A configuration monitor specifies STOL directives that will be issued whenever their corresponding conditions become true. An equation processor is merely a configuration monitor whose STOL directives are all assignment (*let*) directives. State modelling and lights out operations are possible using configuration monitors.